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Scale Row Formulae in *Elaphe guttata* (Linnaeus) and Notes on Their Interpretation

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INTRODUCTION

Scale row alteration formulae, both complete and abbreviated, are common tools of snake systematists. Abbreviated dorsal scale row formulae (in which only the number of dorsal scale rows on the neck, at mid-body, and at the vent are enumerated) are standard instruments when snake taxa are described, and their universal use presumably stems from the ease of accumulating these data. Complete dorsal scale row formulae (usually presented by the Dowling, 1951, method) are commonly shown for one to a few examples of each taxon and are rarely illustrated for large series, presumably because the formulae are frequently complex and their construction is time consuming (notable exceptions are Wilson, 1970, and Keiser, 1974) . An additional problem is that reductions take place in the vicinity of the pancreas in many snakes. The digestive juices of the pancreas frequently continue to operate after preservation rendering this portion of the body weakened and the scale rows difficult to follow.

Until recently (Thomas, *in press)* , few attempts have been made to improve these techniques or to explain the significance of scale row variation. The intent of this paper is to illustrate and comment on the interpretation of dorsal scale row formula variation in *Elaphe guttata.*

ABBREVIATED DORSAL SCALE Row FORMULAE

This formula was constructed for 721 specimens of *Elaphe guttata.* The large number of dorsal rows present in this genus lends itself to considerable variation ; snakes with fewer scale rows show less variation in this character *(fide* Clark and Inger, 1942 ; pers. observation) . Sixty-seven different combinations were observed for this character in *E. guttata* with 25-27-19 being the modal formula (37.6%) . Despite this immense variation, several statements may be made concerning trends in variability.

There is no marked difference between the number of possible formula

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types found in each sex (males have 85.1% of the 67 types and females have 70.1%). The following formulae are found more often in males than females (only samples of five or more occurrences are considered):

23-25-19	25-26-19	25-29-19
23-27-19	25-27-19	26-27-19
24-27-19	25-27-20	27-27-19
25-25-19	25-28-19	27-29-19

All samples considered, 74.6% of individuals with reductions proceeding to 19 rows or less are males. The following formulae are most common in females:

24-25-19	25-29-21	27-29-21
25-27-21	26-29-23	27-30-21
25-28-21	27-28-21	27-31-21

Females are in the majority (60.4%) in formulae ending in 21 rows or more when all samples are tabulated. These percentages indicate that there is not total sexual dimorphism for this character as in the colubrids *Bothrolycus ater* (males have two fewer scale rows on the anterior portion of the body, *fide* Boulenger, 1919) and *Chironius scurrulus* and *C. fuscus* (males have two scale rows fewer anterior to the vent, *teste* J. A. Wiest, Jr.). Procter (1919) mentions that snakes tend to have more rows in areas subjected to intense stress (e.g., the neck and stomach areas while engulfing food. She insinuates that females have a "greater girth" (hence more scale rows) in the posterior quarter of the body due to stress during the development of young. These statements are consonant with scutellation data for *E. guttata,* but no data are present to support the "stress" theory, especially since there are fewer scale rows on the neck than at mid-body in this species.

It should be noted that a single male (LACM 21556) from Miami, Florida, had a formula of 19-19-14. This highly aberrant specimen also possessed only 37 subcaudals.

COMPLETE DORSAL SCALE Row FORMULAE

This formula was determined for 57 specimens of *E. guttata* and is presented in the format of Dowling (1951) with two minor improvements. The initial count was consistently made over the tenth ventral (see Thomas, *in press)* and when the formula required more than one line for presentation, the number of current scale rows was repeated at the beginning of the new line.

Many snakes possess occasional additions-reductions on only one side of the body (see formula for TCWC 42400 below). These alterations, here termed *unilateral,* are randomly encountered in populations and may occur anywhere on the body. Scale row alterations usually occur on opposite sides of the body over closely approximated ventrals and may be called *bilateral* (as in Clark and Inger, 1942). We believe that bilateral alterations are most meaningful in species for which scale row alterations have been investigated and, unless some definite, consistent pattern is observed, unilateral alterations (the possible importance of which is alluded to by Smith, 1967) may be disregarded. Of most im-

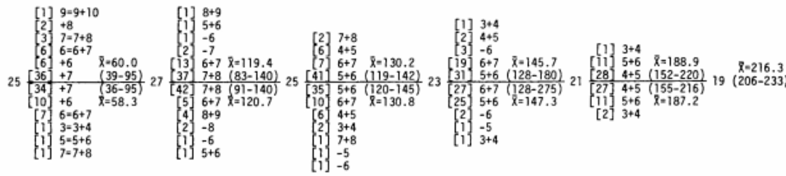

Figure 1. Summation of scale row formulae for *Elaphe guttata.* Only the typical alterations are illustrated. All forms of scale alterations encountered at each addition-reduction site are listed (their frequencies in brackets) and the range (in parentheses) and mean of ventrals over which they occur is given.

portance are 1) the scale rows involved in the alteration and 2) where the change takes place on the body relative to total ventrals (also see Wilson, 1967) .

A summation of the principle scale row alterations, including only bilateral changes for a "typical" example having a maximum of 27 rows and a minimum of 19, appears in Fig. 1 (see Thomas, *in press,* for discussion) . From this condensed formula, it is evident that, for the specimens examined, the most common rows affected in the addition and/or reductions are as follows (percentages of cases in parentheses) :

$$25\;\frac{\overset{(66.7)}{+7}}{\underset{(63.0)}{+7}}\;27\;\frac{\overset{(67.3)}{7+8}}{\underset{(76.4)}{7+8}}\;25\;\frac{\overset{(74.6)}{5+6}}{\underset{(62.5)}{5+6}}\;23\;\frac{\overset{(55.4)}{5+6}}{\underset{(48.2)}{6+7}}\;21\;\frac{\overset{(70.0)}{4+5}}{\underset{(67.5)}{4+5}}\;19$$

These percentages corroborate Wilson's (1967) and Dowling's (1967) comments that scale row alterations "normally" involve the same rows on opposite sides of the body at any given point in closely related snakes. A selection of the most common forms of scale row formulae found in *E. guttata* follow :

1. *Orderly Addition-Reduction.* The abbreviated formulae listed for which a complete formula is presented below are those most frequently encountered.

   a. 25-27-19. USL 7646 (Illinois).

$$25\ (10)\ \frac{6=6+7\ (58)}{+7\ (52)}\ 27\ \frac{7+8\ (122)}{6+7\ (120)}\ 25\ \frac{5+6\ (130)}{5+6\ (129)}\ 23\ \frac{5+6\ (138)}{-6\ (137)}\ 21$$

$$21\ \frac{4+5\ (191)}{4+5\ (185)}\ 19\ (224)$$

   b. 25-27-21 UNSM 501 (Nebraska).

$$25\ (10)\ \frac{+7\ (60)}{+7\ (62)}\ 27\ \frac{7+8\ (118)}{7+8\ (117)}\ 25\ \frac{4+5\ (127)}{5+6\ (127)}\ 23\ \frac{5+6\ (146)}{5+6\ (151)}\ 21\ (206)$$

The second (25-29-21) and fourth (25-29-19) most commonly encountered types showed at least one unilateral scale row change (e.g., SRSU 3175 and EAL 2705, respectively.)

2. *Precloacal Increase.* This type increases anterior to the cloaca after decreasing to the minimum number of rows. CA 3760 (Utah).

$$25\ (10)\ \frac{+7\ (50)}{+7\ (46)}\ 27\ \frac{6+7\ (119)}{7+8\ (120)}\ 25\ \frac{5+6\ (131)}{5+6\ (130)}\ 23\ \frac{5+6\ (143)}{5+6\ (144)}\ 21$$

$$21\ \frac{4+5\ (203)}{4+5\ (205)}\ 19\ \frac{4=4+5\ (208)}{4+4+5\ (207)}\ 21\ (211)$$

3. *Appearance of No Pre-mid-body Alteration.* Many colubrid genera lack change in dorsal scale row number on the anterior half of the body (e.g., *Coluber*) . An instance of an abbreviated evaluation being misleading is illustrated by the following example for which the abbreviated formula was originally taken as 25-25-19. SIU-R 1234 (Illinois).

$$25\ (10)\frac{5+6\ (19)}{5+6\ (21)}\ 23\ \frac{6+6+7\ (38)}{+5\ (39)}\ 25\ \frac{5+6\ (120)}{5+6\ (121)}\ 23\ \frac{5+6\ (129)}{5+6\ (130)}\ 21$$

$$21\ \frac{4+5\ (168)}{4+5\ (169)}\ 19\ (208)$$

4. *Highly Variable.* This form of dorsal scale row alteration consists of unilateral changes interspaced with bilateral alterations. Such variants are found throughout the range of *E. guttata* and an extreme example follows: TCWC 42400 (Texas) .

$$23\ (10)\ \frac{}{4+5\ (21)}\ 22\ \frac{+2\ (24)}{+3\ (24)}\ 24\ \frac{}{-2\ (28)}\ 23\ \frac{2+3\ (30)}{4=4+5\ (31)}\ 23$$

$$23\ \frac{+3\ (35)}{}\ 24\ \frac{4+5\ (36)}{3=3+4\ (37)}\ 24\ \frac{+6\ (39)}{}\ 25\ \frac{+7\ (77)}{+6\ (75)}\ 27$$

$$27\ \frac{-7\ (117)}{-6\ (119)}\ 25\ \frac{5+6\ (126)}{3+4\ (123)}\ 23\ \frac{}{3+4\ (137)}\ 22\ \frac{}{3=3+4\ (138)}\ 23$$

$$23\ \frac{3+4\ (142)}{3+4\ (141)}\ 21\ \frac{}{5=5+6\ (150)}\ 22\ \frac{}{5+6\ (152)}\ 21\ \frac{}{3+4\ (168)}\ 20$$

$$20\ \frac{}{3=3+4\ (170)}\ 21\ \frac{}{3+4\ (172)}\ 20\ \frac{}{3=3+4\ (174)}\ 21$$

$$21\ \frac{2+3\ (184)}{}\ 20\ \frac{2=2+3\ (186)}{}\ 21\ \frac{}{3+4\ (204)}\ 20\ \frac{}{3=3+4\ (206)}\ 21$$

$$21\ \frac{}{3+4\ (207)}\ 20\ \frac{}{3=3+4\ (209)}\ 21\ \frac{}{1+2\ (212)}\ 20\ (213)$$

DISCUSSION

Geographic variation of these formulae is consistent in only one feature : as one proceeds from north to south, any given scale row alteration generally occurs more posteriad. Examination of the average ventral counts of *E. guttata* indicates that there is a north-to-south clinal increase ; hence, additions-reductions tend to occur more posteriad as the vental number increases. It is also correlated with sexual dimorphism in ventral number. Females have more ventrals and their scale row alterations generally occur more posteriad than in males.

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LITERATURE CITED

Boulenger, G. A. 1919. Un cas de dimorphism sexuel chez un serpent Africain *(Bothrolycus ater* Gunth.) . Inst. France, C. R. Acad. Sci., 169: 606-607.

Clark, P. J. and R. F. Inger. 1942. Scale reduction in snakes. Copeia, 1942: 163-170.

Dowling, H. G. 1951. A proposed method of expressing scale reductions in snakes. Copeia, 1951 : 131-134.

______. 1967. Hemipenes and other characters in colubrid classification. Herpetologica, 23 : 138-142.

Keiser, E. D., Jr. 1974. A systematic study of the neotropical vine snake *Oxybelis aeneus* (Wagler) . Bull. Texas Mem. Mus., 22 : 1-51.

Procter, J. B. 1919. On the variation in the number of dorsal scale-rows in our British snakes. Proc. Zool. Soc. London, 1919: 357-364.

Smith, H. M. 1967. A simplified, linear method for notation of scale-row variation in snakes. Turtox News, 45 : 120-121.

Thomas, R. A. *in press*. Comments on the use of dorsal scale row formulae in snakes. Copeia.

Wilson, L. D. 1967. Comments on Smith's method of expressing scale reduction pattern in snakes. Turtox News, 45: 170.

________. 1970. The coachwhip snake, *Masticophis flagellum* (Shaw) : Taxonomy and distribution. Tulane Stud. Zool.-Bot., 16: 31-99.

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